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E-Finance: An Introduction

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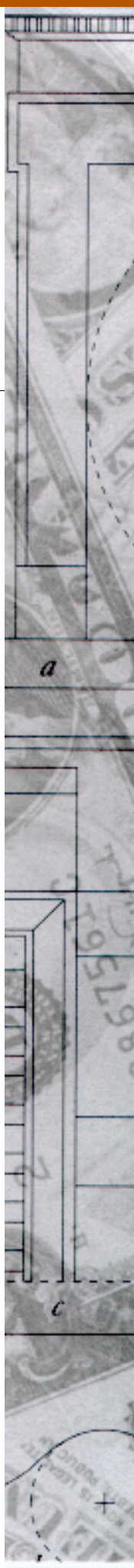

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The Working Paper Series is made possible by a generous grant from the Alfred P. Sloan Foundation

E-FINANCE:

AN INTRODUCTION

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October 7, 2001

Abstract

E-finance is defined as “The provision of financial services and markets using electronic communication and computation”. In this paper we outline research issues related to e-finance that we believe set the stage for further work in this field. Three areas are focused on. These are the use of electronic payments systems, the operations of financial services firms and the operation of financial markets. A number of research issues are raised. For example, is the widespread use of paper-based checks efficient? Will the financial services industry be fundamentally changed by the advent of the internet? Why have there been such large differences in changes to market microstructure across different financial markets?

1. Introduction

How important are electronic communication technologies and the Internet for finance? Is the Internet the most significant development for many decades or is it just one among many? One view is that it will fundamentally transform the financial services industry and financial markets. Another is that the net represents the latest in a long line of electronic technologies that have reshaped the financial industry. These issues were addressed at a conference held at the Federal Reserve Bank of New York on February 23 and 24, 2001. This volume contains papers presented there. The purpose of this article is to review these, frame the issues related to the use of the Internet and other types of electronic communication technologies in finance, and stimulate future research. We attempt to draw out the many interesting questions to be answered below.

What exactly is e-finance? The definition that is used as the basis of this article is:

The provision of financial services and markets using electronic communication and computation.

Claessens, Glaessner and Klingebiel (this volume) provide an overview of the state of e-finance around the world. The developments can be divided into two broad areas. The first is the impact on banking and financial services. They argue that the advent of the internet and other electronic communication means has fundamentally altered many aspects of the banking industry. Many of the services traditionally provided by banks are being provided by other entities. The second broad area is the transformation of financial markets. These no longer need

to be associated with a physical place. As a result trading systems for equities, bonds and foreign exchange are becoming global. All these changes have important significance for public policy towards the financial services industry and financial markets. They consider the implications for safety and soundness regulation, competition policy, consumer and investor protection, and global public policy.

Three important trends in the financial services industry have been accelerated by the emergence of the internet. These are improved price transparency, differential pricing and transformation of distribution channels. Clemons et al. (this volume) consider the impact of these trends on the financial services industry. Improved price transparency potentially increases competition and reduces profit margins. Evidence from other industries that make extensive use of the internet, however, suggests that there are limits to this process. It appears that transaction costs of search remain sufficiently high that differential pricing is possible and this will become increasingly important in financial services. As increased use of the internet leads to the unbundling of services and promotes disintermediation, there will be a transformation of distribution channels and an important restructuring of the industry.

Section 2 of our overview considers broadly the impact of e-finance technologies on financial services firms. Online banking began in the mid 1990s and is steadily becoming more important. In contrast to banks, however, insurance companies have used the internet a relatively small amount. Electronic brokerage services have been an important development in recent years. Firms such as Schwab and E*Trade have developed significant discount brokerage businesses over the net. While the internet is new and exciting, we discuss how other e-finance technologies, many of which have been around longer than the internet, have also reshaped the

financial services industry, particularly the banking sector. For example, starting in the 1970s, Automated Teller Machines (ATMs) began to alter the ways that consumers interact with banks. In the 1980s, greater use of electronic computation and data analysis changed the way credit decisions are made; these innovations have both reduced the cost of lending on average and enhanced the liquidity and marketability of loans.

The use of electronic communication in finance, in fact, goes back much further than the 1970s. As long ago as 1918, the Fedwire payment system allowed electronic settlement of payments between banks over the telegraph. This use of electronic communications in payments systems has steadily increased over time. Now virtually all large payments between banks and corporations are done electronically. In some countries, such as those in Scandinavia, electronic payments systems are becoming increasingly widely used at the consumer level. In the U.S., however, the paper-based check clearing system still predominates. In Section 3, we discuss in some detail how e-finance is changing the payments systems. In our view, insufficient attention has been paid to these developments. Our purpose in this section is to highlight the many interesting theoretical and policy questions surrounding the evolution of payments systems and, we hope, stimulate further research.

We consider the role of electronic communications in the securities markets in Section 4. Nasdaq was an early example of a stock market that was based on electronic communication means. Many others around the world have followed suit and now the NYSE remains one of the few stock markets that retains traditional means of trading. The foreign exchange market was a telephone-based dealer market for many years. Recently it has increasingly migrated to the internet and this trend is expected to continue. Finally, the bond market has also traditionally

been a dealer market. Unlike the stock market or the market for foreign exchange, however, the bond market has not been transformed by the advent of electronic trading systems.

Concluding remarks are contained in Section 5.

2. E-Finance and the Financial Services Industry

This section begins by describing how different kinds of financial services firms, depository institutions, insurance companies and securities companies, have deployed e-finance technologies. Then, we discuss how these new technologies have reshaped the role and structure of the financial services sector. We attempt throughout the section to draw out the research questions and policy issues raised by the advent of new e-finance technologies.

A. Adoption of e-finance by financial services firms

Financial Intermediaries

By the end of the 1990s, e-finance technologies had arguably affected all aspects of the business of banking and financial intermediation, with the possible exception of lending to large businesses. Depository institutions have used electronic information technologies, for example, to make credit decisions to consumers since the 1980s. Having computation abilities that allow the use of large databases has made this possible. For consumers, the application and approval process for both mortgages and credit cards has become sufficiently automated so that it can be done without any personal contact with the lender. The ability to make these credit decisions in this way depends crucially on standardized information provided to lenders by a small number of credit bureaus that keep track of individuals' credit histories. With respect to credit cards, their use as a medium to make payments, along with debit cards, has grown dramatically, fueled by

rapid communications technologies that allow vendors to validate a person's credit worthiness in seconds.

In recent years, information technologies have also been used systematically for lending to small businesses. Since the early 1990s, banks and finance companies have been using credit scoring models to lend to small businesses on a wide scale. These models use information about borrower quality, such as the credit history of the proprietor, to estimate the likelihood that a particular small business loan will default; loan applications with a sufficiently low default likelihood (high "score") are granted. Survey evidence suggests that large banks have been the first to use credit scoring for their small business loans, and that these models are generally used only for very small, small business loans such as those under $100,000 (Mester 1997). Smaller banks have also gotten access to credit scoring technologies, however, through the efforts of third parties such as Fair Isaac. These companies aggregate information on the performance of loans to many small businesses (and other borrowers) to produce generic credit scores that can be used by any lender, large or small. In this way, these third parties allow smaller financial institutions to take advantage of a technology that comes with very substantial scale economies.

The widespread use of these information technologies have made it increasingly easy for banks to remain at "arm's length" from their borrowers. Over the past two decades, for example, the probability that a bank communicates with its small business borrower in person rather than with the phone or mail has declined from 59 percent in 1973 to 36 percent in 1993. Moreover, the average geographical distance from a bank to its typical small business borrower has increased from 16 miles during the 1973-79 period to 68 miles during the 1990-93 period (Petersen and Rajan, 2001).

Surveys by the Federal banking regulators suggest that depository institutions in very recent years have also invested heavily in e-finance technologies (e.g. website on the internet) as a means to distribute their products to retail customer. As described by Furst et al. (this volume), by 1999 banks with transactional websites – websites capable of allowing customers to conduct business – held more than 90 percent of banking assets. Banks have used the internet as an alternative means to distribute their traditional credit and payments products to retail customers. For example, Furst et al. find that most internet banks offer balance inquiry and funds transfer, bill payment and credit applications online. In contrast, fewer banks with transactional website offer brokerage, cash management, fiduciary or insurance services online, although this may reflect the fact that fewer banks provide these services.

The rapid increase in the use of the internet represents a continuation of banks' efforts to replace their costly branch network with alternative distribution channels such as the telephones, the mail and Automated Teller Machines (Radecki, Wenninger and Orlow, 1997). Although ATMs have existed since the middle of the 1970s, as discussed in Section 2 their numbers have grown dramatically in recent times. Having said that, the number of offices at banks and savings institutions continues to grow, albeit slowly. Over the second half of the 1990s, for example, the total number of offices at depositories rose from about 80,000 in 1995 to a little more than 85,000 in 2000.[1]

Furst et al. also find that large banks have adopted these technologies very aggressively during the late 1990s, and that these technologies have been associated with relatively high profits and efficiency. An open question, however, is whether adoption of the internet (and other

[1] Figure are based on statistics reported on the FDIC's website, http://www2.fdic.gov/hsob.

e-finance technologies) has itself enhanced profits, or whether the more efficient and higher profits banks were simply first to adopt the technology. They report that *de novo* banks that attempt to use websites as their primary means for interacting with customers have not been successful to date, suggesting that e-finance technologies can not supplant traditional distribution channels entirely. This suggests a slightly broader question: are banks using the internet to enhance their existing delivery channels ("bricks *and* clicks") or to supplant them ("bricks *or* clicks")? In other words, are branches and websites substitutes or complements?

Insurance

Like the securities underwriting business, the insurance industry also has not seemed to adopt e-finance technologies in large numbers yet. For example, in 1999 12% of US insurers used the internet to sell products amounting to 1% of the total sales (Banks, 2001). Insurance companies tend to buy and hold securities (mainly debt securities) issued or originated by someone else, thus limiting the potential usefulness of e-finance on the asset side of the business. On the liability side, slow adoption of e-finance technologies may reflect the relative infrequency with which an insurer and retail customer interact. In contrast to bank depositors, policyholders generally interact with their insurer only at the time of sale and when filing a claim. Also in contrast to banking services, insurance policies tend to be quite heterogeneous and consumers tend not to be well informed about the products, making automation of the sales process difficult. Differences in regulation may also play a role. The issue of why the insurance industry has been relatively slow to use the internet needs further study.

Securities Firms

E-finance has also affected the securities industry, particularly for the broker-dealers in

the secondary securities markets. During the 1990s, the discount brokerage business rapidly gained market share. Discounters typically rely on fees from retail customers with few ancillary services, thereby allowing individuals to trade securities at very low cost. From 1990 to 1999, employment at discount brokers rose from 2.4 percent to 5.3 percent of total employment in the securities industry. Moreover, the discounters enjoyed a higher profit rate (pre-tax return on equity) than national full-line securities firms or large investment banks in *every* year from 1990 to 1999 (Securities Industry Fact Book, 2000).

Will e-finance technologies reshape the primary securities markets to the same extent that it has affected the brokerage business? The traditional approach to bringing a new security to the primary market involves "book building," a process by which investment banks assess the demand for a security issuance from a small number of well-connected institutional investors before finalizing the terms of the offering. Wilhelm (1999) argues that the relationship-based approach to book building has allowed information to be collected efficiently in an environment of high search and information costs. By lowering these search and information costs, however, e-finance technologies may reduce the comparative advantage of the relationship-based approach relative to a more arm's length process, such as an online auction.

Some online IPOs have succeeded over the past five years, beginning with the Spring Street Brewery in 1995 (Banks 2001). More than 3,500 people bought shares in the $1.6 million offering over the internet. The shares were subsequently traded on an internet bulletin board called Wit-trade. The SEC investigated the primary issue market and the secondary trading and issued a no-action letter. In 1999, W.R. Hambrecht created an online auction (OpenIPO) available to any individual or institutional investor that has brought several companies public.

OpenIPO operates a Dutch auction in which participants pay the minimum price necessary to sell all of the shares offered. According to the Hambrecht website, six companies have used the OpenIPO format successfully since 1999.[2] Whether the online auction model of securities underwriting represents a real threat to traditional securities underwriting methods remains to be seen. Many studies have found that securities are underpriced when first sold to the public, suggesting that issuers sacrifice substantial amounts of capital by using the traditional underwriting approach (Loughran, Ritter and Rydqvist 1995). Thus, an important question for future empirical research is whether securities sold in an open auction yield less underpricing than securities sold using the traditional, relationship-based technology.

B. The Effects of E-finance on the Financial Services Sector

Disintermediation

The advent of e-finance technologies furthers the long-standing evolution of the financial services sector from one dominated by financial intermediaries to one dominated by capital markets and financial institutions that hold *marketable* securities as assets. Traditional financial intermediaries transform illiquid, hence non-marketable, assets (e.g. bank loans) into liquid liabilities (e.g. demand deposits). This role has become less important over time as the liquidity of financial assets originated by intermediaries has increased. Liquidity depends crucially on the ability of buyers and sellers to agree on the value of a financial assets. Liquidity is reduced by asymmetric information – sellers knowing more than buyers – because buyers assume,

[2] They are Briazz, Inc., Peet's Coffee, Nogatech, Andover.net, Salon.com, and Ravenswood. See

rationally, that informed sellers want to keep high quality assets and sell low quality ones. E-finance technologies reduce asymmetric information because they lower the costs of communication, computation and data processing, thus allowing buyers and sellers of financial assets to have more equal access to information.

Securitization of small business loans offers a concrete example of how e-finance technologies enhance the liquidity of a formerly illiquid class of financial assets. Small business lending had traditionally been based on information developed from a long-term relationship between lender and borrower. As a result, outsider investors had no reliable way to evaluate these loans and they remained illiquid. Over the past decade, however, banks and finance companies have begun to replace relationship-based lending with an automated credit scoring system that allows outside ratings agencies to evaluate the credit risks inherent in a pool of these loans. According to a recent Federal Reserve Board Report on Congress (2000), more than 300 large small business lenders use a common credit scoring system developed by Fair Isaac. Because pools of small business loans can now be standardized and rated, securitization of small business loans have been able to occur, growing *tenfold* between 1995 and 1999, from $241 million to $2.3 billion.[3]

While the growth rates are impressive, securitization of small business loans has remained a small part of this market. In lending to consumers, however, securitization has become widespread. By the end of the 1990s, over half of residential mortgages were being

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http://www.wrhambrecht.com/offerings/completed.html.

[3] These figures include conventional small business loans and the unguaranteed portion of loans backed by the the Small Business Administration. See Federal Reserve Board Report on Congress (2000).

securitized, about 45 percent of credit card loans were securitized, and about 10 percent of other consumer loans were securitized (Mishkin and Strahan, 1999). Thus, an interesting question for research is whether securitization will continue to spread. Will securitization of small business loans become as pervasive as in mortgage and consumer lending? What about lending to large businesses? And, how important are systematic data processing technologies in reducing the adverse selection problems that make assets illiquid and hard to securitize?

As a result of the increasing liquidity of financial assets, depository institutions have lost market share to mutual funds and pension funds. Between 1980 and 1998, for example, the share of all financial institution assets held by depositories fell from 58 percent to 31 percent, while the share held by mutual funds and pension funds rose from 21 percent to 49 percent (Mishkin and Strahan, 1999).[4] Moreover, the decline in the market share of intermediaries arguably understates the decline of traditional financial intermediation because an increasing share of the assets that remain on their balance sheets could be sold or securitized. This change reflects *disintermediation*; assets have migrated from intermediaries that provide asset transformation services, to financial institutions that provide very little or no asset transformation. (Mutual funds and pension funds hold mainly marketable securities as assets -- commercial paper, corporate debt, mortage-backed securities, government securities, etc.) As this discussion suggests, traditional intermediation has been declining for many years. An interesting research question looking ahead is whether e-finance technologies will push this process along, or whether banks and other intermediaries can use these technologies to encourage re-intermediation, as argued by Domowitz (this volume).

How will disintermediation affect monetary policy? By weakening the link between the

[4] The market share of insurance companies and other financial institutions has remained relatively constant over this period.

liabilities and assets in the banking system, disintermediation creates a challenge for central bankers. The central bank has direct influence only over the liabilities of banks and other depository institutions, but innovations such as securitization allow banks to continue to originate loans even if funding becomes scarce. Monetary policy is thought to operate both through its effects on interest rates and through its effects on lending by banks.[5] As bank lending becomes less important and less tied to their liabilities, however, this second "credit channel" of monetary policy may lose its potency (Lown and Morgan, 2001). Estrella (2001) in fact shows that securitization in mortgage markets has reduced the effects of a monetary policy shock and, at the same time, altered the channels through which those shocks operate. At a minimum, disintermediation complicates the life of the central banker by increasing the already substantial degree of uncertainty inherent in the job.

Another important question is whether disintermediation will change the way the financial system allows agents to share risks. Allen and Gale (1997) argue that bank-based financial systems eliminate risk through inter-temporal smoothing. Banks are able to build up reserves in good times and run them down in bad times. Disintermediation prevents this from happening because assets will be marked to the market and the current owners will obtain the full increase in value. The extent to which e-finance leads to this type of disintermediation remains an empirical issue.

Consolidation

Consolidation in the banking sector has gone hand-in-hand with disintermediation, perhaps reflecting the joint effects of e-finance. At the same time that it lowers transactions and information costs, e-finance technologies raise scale economies. On the liability side, for

[5] There is a large literature on the channels of monetary policy that we will not cite here. See, for example, Bernanke and Blinder (1992) and Gertler and Gilchrist (1994).

example, electronic payments technologies require large fixed investments and often require networks that exhibit increasing returns. On the asset side, for example, credit scoring models rely on statistical analysis of default risks which perform better with larger databases, thus giving large lenders a significant advantage over their smaller competitors. Studies using the experience of the 1980s typically found very limited economies of scale in the banking industry, but more recent studies using data from the 1990s suggest scale economies up to $10 to $25 billion in assets.[6] Although data limitations make it difficult to study effects of e-finance technologies directly, recent evidence suggests that electronic payments processing at the Federal Reserve Banks exhibit significant scale economies (Hancock, Humphrey and Wilcox, 1999).

In part as a result of these increased economies of scale, banking has consolidated very dramatically over the last decade. The largest 10 banking organizations in the U.S. accounted for 27 percent of all operating income in 1990, compared to their share of 45 percent in 1999.[7] This trend toward increased consolidation, however, has been conspicuous by its absence in the rest of the financial services industry. In securities, for example, the share of revenue from the top 10 firms accounted for 57 percent of industry revenues in 1999, *down* from 64 percent in 1990 (Securities Industry Association, 2000). In life insurance, the share of assets held by the largest eight firms *fell* from 42 percent in 1988 to 35 percent in 1996, while in property & casualty insurance the share of assets held by the largest eight firms rose only slightly, from 33 percent in 1988 to 36 percent in 1996 (Berger, Demsetz and Strahan ,1999).

Given these facts, an important question is: why is banking the only segment in financial services to consolidate? Two key differences between banking and other financial institutions

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[6] For an overview of this large literature, see Berger, Demsetz and Strahan (1999).

[7] Operating income equals net interest income plus non-interest income. Figures are based on the authors' calculations from data in the 1990 and 1999 fourth quarter *Reports of Income and Condition.*

come to mind. First, banking was inefficiently balkanized during the 1970s and 80s because of regulations restricting both geographic and product markets. Thus, deregulation generated much of the consolidation of the past two decades (Jayaratne and Strahan, 1998). Second, e-finance technologies have had perhaps there greatest effect on the banking industry (and on other financial intermediaries), where the asset transformation role has been dramatically affected by reductions in transactions and information costs. While the role of the financial intermediary itself is threatened by e-finance technologies, the same can't be said for either securities firms, or other financial institutions that rely little on asset transformation (e.g. mutual funds, pension funds, or insurance companies). Because e-finance technologies bring large scale economies, it makes sense that we have seen much more consolidation in banking than in other parts of the financial services industry. Moreover, in the securities industry e-finance may explain some of the declines in consolidation as discount brokers experienced dramatic growth, thus taking market share away from the large, full-service investment banks.

From a public policy perspective, the consolidation in U.S. banking raises few antitrust concerns, at least over the short run. At the same time that e-finance technologies increase scale economies, they also lower barriers to entry into new markets, both geographic and product. Petersen and Rajan (2001) find that small businesses tend to borrow from more distant banks now than in the past, and that this increase in distance occurred because banks now use communications and information technologies more intensively when making credit decisions. While research of banking markets from the 1980s suggested that prices and profits were higher in more concentrated local markets, evidence from the 1990s is less supportive of the idea that local market concentration raises the price of banking services (Hannan 1997, Radecki 1998, Strahan and Hannan 2000).

Like the U.S., banking markets in Europe have been opened to greater competition with

deregulation and the possibility of cross-border banking. Also like the U.S., consolidation has occurred in European banking, but most of this consolidation has been between banks operating in the same country. Danthine, Giavazzi, Vives and Von-Thadden (1999) report the slow growth of cross-border banking in Europe during the 1990s. In 1992, for example, 4.7 percent of deposits held by French households and non-bank businesses were with foreign banks; this percentage increased to just 5.8 percent by 1998. The figures did increase in France and in other European countries, but they increased quite slowly. It is an important research issue why European deregulation not yet created a single banking market. The relatively slow process of financial integration in Europe represents a significant puzzle, particularly because the deregulation occurred at a time when e-finance technologies have made it easier for customers to bank anywhere. Monetary union, to be completed in 2002, would seem to remove the last remaining explicit impediment to creating a unified banking and financial system in Europe.

Access to Credit

How will e-finance technologies affect access to credit, particularly for borrowers that rely on a relationship with their lender? Small businesses tend to concentrate their borrowing at a single bank with which they have a long-term relationship, and the cost of credit seems to be lower when banks forge a relationship with them (Petersen and Rajan,1994 and Berger and Udell, 1995). As banks invest more of their capital in automating the lending process, less may be available to invest in these relationships. This requires further research.

Beyond the direct effect on relationship customers, the competition and consolidation fostered by e-finance technologies can also conceivably harm the relationship-based customer. Some studies, for example, suggest that increased competition can hurt small and young firms by reducing the incentive for banks to forge long-term relationships with them (Petersen and Rajan, 1995, Boot and Thakor, 2000 and Marquez, forthcoming). In competitive markets, for example,

it may be difficult for borrowers to commit to maintaining a long-term relationship. Lenders may therefore be less willing to offer credit on good terms early in the life of a firm because they have little confidence that they can recover their investment if the firm prospers.

Will consolidation also potentially harm relationship borrowers? Small banks have traditionally been important lenders to small firms, and some authors have argued that this role reflects their comparative advantage in relationship lending. Information stemming from a relationship is generated and controlled by a human being (the loan office) rather than a machine (the computer), and small banks may be better able to control the agency problem that is generated by the private information held by the loan officer than a larger, more bureaucratic, bank.

While there may be theoretical reasons why increased competition and consolidation could reduce credit availability to relationship borrowers, one can argue the other side as well. The first-order effect of banking competition is to spur innovation and force prices closer to marginal costs. Moreover, increased bank size that comes with consolidation also ought to lower lending costs overall, both because size reduces the need to hold costly capital, and because banks' incentives to monitor their borrowers effectively are enhanced when their probability of failure is reduced through diversification (Diamond (1984)). The empirical evidence needed to sort this issue out remains inconclusive and further work is needed.[8]

[8] See, for example, Keeton (1996,1997), Peek and Rosengren (1996,1998), Strahan and Weston (1998), Craig and Santos (1997), Kolari and Zardkoohi (1997a,b), Zardkoohi and Kolari (1997), Walraven (1997), Berger, Saunders, Scalise, and Udell (1998), Sapienza (1998), Berger, Demsetz and Strahan (1999), Cole and Walraven (1999), Jayaratne and Wolken (1999), Bonacorrsi di Patti and Dell'ariccia (2000), Black and Strahan (forthcoming), and Cetorelli and Gambera (forthcoming) .

3. E-Finance Technologies in Payment Services

Electronic communications technologies have been used in the banking sector for many years, particularly in interbank payment systems. One of the early applications of electronic communication networks to finance was the Fedwire payment system. By 1918 this linked the accounts of banks held at the twelve Federal Reserve Banks across the U.S. using leased telegraph wires and inaugurated electronic settlement of accounts. This facility, combined with the ability to settle in central bank balances, eliminated the fluctuating exchange rates that had previously been common between bank balances due from banks located in different regions of the country.[9] This early application of electronic communication in finance displays one of the heralded features of Internet communications: the importance of distance was reduced as telegraphic instructions to adjust central bank balances replaced the need to physically ship coin and currency. In this case, the advent of the specialized intermediary, the central bank, and the electronic communication method served to substitute for existing currency exchanges.

Electronic payment systems have evolved over the decades. Interbank payment systems in the industrialized countries typically utilize dedicated telephone networks and mainframe computer systems to manage their payments, which are characterized by high volumes and values of payments. Many other payment systems, some intended for lower-value payments, have also adopted electronic infrastructure. In the U.S. the automated clearing house (ACH) system was designed and built in the 1970s and is widely used for the payment of wages and other recurring payments.[10] Many European Giro systems have adopted electronic formats to reduce paper processing, as did the credit card associations, both in the 1970s. The electronic

[9] See Gilbert (1997) and Garbade and Silber (1979) for a review of the early history of the Federal Reserve's activity in payments and some of its effects.

[10] The ACH was built partly in response to the "paper crisis" of the late 1960s, which also spurred adoption of electronic methods for settling securities transactions.

communication and computation technologies associated with these payment systems are clearly complementary to banks' activities.

Another type of electronic technology banks have invested in is the automated teller machine (ATM) and the network facilities that allow depositors remote access to their bank accounts at any time of day. While the number of bank offices has continued to rise gradually over the past 20 years, the number of ATMs has exploded, from 18,500 in 1980 to 324,000 by 2000 (Thompson Financial, 2001). ATMs add convenience for the depositor, but they do not seem to substitute for the branch. Rather it seems they are complements.

Although electronic payments systems have long played the dominant role in the U.S. for interbank transactions, the same cannot be said for customer transactions. The check is still the single most widely used non-cash payment instrument in the U.S. However, its dominance, which dates from the 19th century, is eroding. While checks are estimated to have made up 78 percent of non-cash transactions in 1994, their share fell to 70.7 percent in 1998 (BIS, 2000). Their share of payment volume has been falling as the fast growth in credit and debit card payments outpaces the relatively stagnant growth in check payments. Credit and debit card payments increased their share over that time span from 18.7 percent to 24.5 percent of noncash payments in the U.S. Debit card payments alone increased in number by a factor of 4.2 in that time period.

Although there has been an expansion in the market share of card payments in the U.S., checks continue to be the primary means of bill payment. As checks appear to be more costly than some electronic alternatives, an important research issue is why checks continue to predominate in this use.[11]

[11] See Wells (1996) for a comparison of the private and social costs of checks.

Two alternative hypotheses have been advanced to explain the seemingly slow adoption by consumers of electronic means of bill payment. One hypothesis suggests that the rate of adoption of electronic alternatives to the check is inefficiently slow because of a coordination failure.[12] The other hypothesis suggests that the rate of adoption is efficient, and that the continued prevalence of the check for bill payments reflects both the implicit advantages of the check enjoyed by people who write checks and the costs of adopting the current generation of alternative electronic means of payment. We'll explore these hypotheses in greater detail.

Payment systems are examples of network goods: they consist of originating and receiving participants and intermediaries using complementary components of a technology that, when used jointly, produces a transfer of funds. Costs are borne by all the various participants in a payment system. The intermediaries recover their costs by charging their customers, the senders and receivers of payments, either explicit fees or implicit fees through earnings on deposits held by the intermediary. It is quite common in the U.S. for banks to offer a package of banking services to their depositors that includes a zero marginal cost for writing many checks and some minimum balance the depositor must keep in his or her account.

When an electronic alternative means of payment becomes available, it too imposes costs on each participant. Even if the total cost of the electronic method is less than that of a check payment, it may not be adopted in the short-run at least, because some participant's costs rise relative to the costs of using a check. Consider a consumer, for example, when he or she is considering whether to adopt an electronic bill-payment service. The consumer may well experience an increase in costs to adopt the electronic alternative. First, the consumer has already learned how to make payments by check, while the electronic services are unfamiliar. Second, electronic services typically charge explicit fees for making electronic payments. Third,

[12] See Humphrey and Berger (1990), Humphrey, Kim, and Vale (1998), and Humphrey, Pulley, and Vesala (2000),

the consumer may not be able to pay all their bills via the electronic service, and so may still choose to maintain the zero-marginal-cost-checking service from their bank. Fourth, the consumer will still need to open their bills, maintain the balance in their checking account, etc. For some consumers, the inconvenience of actually writing a check and the cost of buying postage may not impose higher costs relative to the explicit costs and alternative format for the electronic alternative. Finally, the check may offer conveniences relative to some electronic alternatives, including the ability to stop payment, automatic provision of a receipt and proof of payment, control of the timing of payment, etc.

Each of the other participants faces a similar set of comparisons in making their choice of whether to adopt the alternative system. Absent an ability to make side-payments among the parties, the lack of adoption by one class of participants can result in a potentially lower cost alternative system going unused. Some payment instruments, including general-purpose credit cards and point-of-sale debit cards do transfer side-payments, known as interchange fees, from one class of intermediary to another. Other payment instruments, including the check, the automated clearing house, most giro systems, and wholesale systems do not require participants to pay interchange fees; instead those payment instruments are "par" payment instruments, which transfer the full value of the payment between participants. In addition to this difference among alternative systems, some payment systems such as Visa and Mastercard are "branded," operate with a strategy to provide a uniform level of service across end-users, and advertise their services. While these two dichotomous characterizations of payment systems largely coincide with whether the system is operated by private sector or the public sector, some systems operated by the private sector, such as the ACH in the U.S. (whose rules are determined by the National

Mester (2000), Wells (1996), and McAndrews and Roberds (1999) who review these possibilities.

Automated Clearing House Association, a private sector group), explicitly rule out interchange fees, and conduct little brand advertising.

Two important questions arise in considering this brief review of the hypothesis that adoption of electronic alternatives to the check might be inefficiently slow in the U.S. Why do banks offer zero-marginal cost check services? Standard competitive theory suggests that by offering a menu of alternative account relationships, bundling minimum balances and alternative cost check services, banks are engaging in price discrimination. It also suggests that check writing is a normal good, i.e., that those customers who can place a larger balance on deposit are more likely to write many checks. Such a pricing structure is not necessarily inefficient; Wilson (1998) points out situations in which nonlinear pricing schedules can be efficiency enhancing. Generally, these situations include economies of scale in production and demand heterogeneity, or economies of scope in the production of related products. However, if a potentially less costly alternative means of making payments is introduced, banks may have few unilateral incentives to alter their price structure. In such a case, a coordinated movement of prices might overcome the reluctance of banks to unilaterally change their prices. Humphrey, Kim, and Vale (1998) examine such a coordinated move to explicit pricing for checks by banks in Norway. They found that there is significant demand elasticity for checks, indicating that checks and other payment services are highly substitutable. More empirical research is needed to further test this hypothesis. The policy question of how and whether to craft incentives to move more quickly away from the check means of payment is affected by the results of such research.

The second question that occurs is what are the effects of having some payment instruments settle at par, and others settle with a payment of an interchange fee between the intermediaries involved. Interchange fees open up the possibility of a redistribution of the costs of adopting a particular payment instrument among the participants. Such an option can

potentially overcome the reluctance on the part of some of the participants to adopt a payment instrument that otherwise imposes costs on them alone. In particular, as Baxter (1983) pointed out, the payer and the payee both experience benefits from making and receiving a payment, while the two (or more) intermediaries involved experience costs. While the sum of the benefits may exceed the sum of the costs, it may not be the case that the benefits accruing to the payer, for example, exceed the costs to the payer's bank. Interchange fees can redistribute the benefits in such a way as to allow each intermediary to cover its costs without the need to charge a price that exceeds its customer's willingness to pay. The presence of interchange fees in credit and debit cards may have allowed those means of payment to overcome some of the inherent challenges to the adoption of a new payment instrument.[13] However, interchange fees have been the focus of antitrust disputes as well. The role of interchange fees, therefore, is an important issue for research in electronic payments, and may affect the policy question mentioned above. How is one to craft incentives to move more quickly away from check payments?

The other hypothesis explaining the continued use of checks in bill payments also relies on the network aspect of a payment instrument. The hypothesis is that there has been insufficient development of complementary systems to support electronic alternatives to check payment. To take one example of this lack of development, consider the bills companies send to their customers requesting payment. Most bills are in paper form and delivered by mail. They often are delivered with a return envelope. The check is a complementary form of payment for a paper bill, while an electronic means of payment may not be as well integrated with paper processing of account numbers and mail delivery. The hypothesis that electronic alternatives to the check are not well developed can be elaborated in a number of ways, all suggesting that

[13] Baxter (1983), Carlton and Frankel (1995), Chakravorti and To (1999), Schmalensee (2000) and Rochet and

complementary technologies are not yet in place to endow electronic means of payment equal net benefits to the check.

The relatively rapid adoption of the use of debit cards and, more recently, the growth of personal online payment systems, raise questions about the importance of having complementary technologies, legal structure, and business agreements available to foster the growth of payment networks. These examples of successfully introduced payment instruments also raise the question of how differentiated is the demand for payment instruments. Research into these questions is likely to be useful and likely to shed light on whether incumbent payment networks, such as those offered by the credit card associations, are especially well positioned to take advantage of future developments and market demands.

Debit card usage has grown dramatically in the 1990s in the wake of two complementary developments. First was the growth and widespread use of ATMs, cards to access ATMs, and the supporting networks in the 1980s. The presence of ATM networks allowed those organizations to take advantage of economies of scope in the use of their network communication facilities to provide point-of-sale debit card services. The widespread use of the ATM cards allowed consumers to adopt that means of payment without having to acquire yet another card for the purpose of debiting of one's account at the point of sale. Banks had to place devices at the merchant's locations, but this was an easier task than doing that and inducing consumers to carry the cards. The second development was the decision of the credit card networks to offer debit cards on a widespread scale. The credit card networks had widespread merchant acceptance networks and network communications facilities, and could leverage those in providing debit card services.

Tirole (2000) examine the economics of interchange fees.

In addition to these supply-side considerations, the demand for speed and convenience at the point of sale was increasingly satisfied by card methods of payment as electronic authorization methods improved. The speed of card payment authorization has increased over time so that such payments became faster to complete than check payments. This technological development, combined with the many consumer rights enjoyed with card payments (due both to business arrangements and to government regulation) have made card payments increasingly advantageous to consumers.

An interesting use of the card payment system is personal online payments. These were introduced in response to the success of online auctions. eBay, the online auction service, auctions several hundred thousand items per day. Because many of the sellers are individuals, credit cards often are not accepted for payment for a purchase. For such purchases, the main form of payment available to the parties, prior to the introduction of personal online payment systems, was the check. Checks typically do not provide any sort of instantaneous authorization or guarantee that the check will be honored by the bank on which it was drawn. Instead, the check must be "cleared" to determine that the funds will be finally transferred to the seller. In addition, of course, the buyer must deliver the check to the seller, typically sending the check through the mail. These factors imply that in a typical online auction transaction, paid for by check, the seller will not be fully informed about the payment by buyer for many days after the auction occurs.

The delay and lack of integration with the online auction occasioned by a check payment, in contrast to a credit card, led to the innovation of personal online payments. One way to describe the personal online payment providers is to say that they provide intermediation of credit card receipts: they accept a credit card payment from a buyer in an auction, and deliver the payment to the seller by adding credit to the seller's credit card line of credit. This is

accomplished in various ingenious ways, with communication of the payment advice made by e-mail. There has been considerable entry into this field, and many alternate providers offer services. A basic transaction occurs when the buyer funds an account at the provider (usually using a credit card) and notifies the seller via e-mail that he has initiated a payment. The seller clicks on a link in the e-mail to contact the provider to receive payment. The seller receives payment after establishing an account into which the funds are transferred. The provider pays out these funds to the seller by crediting the seller's credit card (or by sending the funds to the seller's bank account using the automated clearing house or by check).

This innovation suggests many useful questions about developments in financial e-commerce. First, it is noteworthy that personal online payment systems developed in response to a specific demand. There have been many attempts to create "e-money" with certain features in the last decade. Most of these attempts were in response to a perceived future demand, often a demand that did not materialize, or for which credit cards were sufficient. The concrete demand by buyers and sellers in online auctions was a significant market for a specific solution to making payments online. It led to a unique solution to this need, which was unforeseen just a few years earlier. Are other distinct demands likely to surface as e-commerce continues to grow? Second, the demand was related to personal transactions. Individual consumers do not typically have access either to more sophisticated and costly communications networks, such as private interdealer value-added telecommunications networks (VANs), nor to the acceptance networks of the credit card systems. It is in this realm of personal transactions, therefore, in which few close substitutes existed, that the innovation took root quickly. One question that arises is whether banks will allow individuals to more easily accept credit card payment directly. This question leads to many other questions regarding the technological feasibility of allowing persons to accept credit card payments, and the business case for doing so. Finally, e-mail was

used as a building block for communication, and the clearing and settlement networks of the credit card associations were relied upon for that part of payment services. These "off-the-shelf" technologies, one a communications and one a financial technology, provided many advantages for this form of payment. By building in these strong technological complementarities, the providers of these payment systems could piggy-back on the widespread use of e-mail and credit cards. The use of these complementary and widespread technologies therefore allowed many consumers to easily adopt personal online payments. A question here is how likely are consumers to adopt relatively customized technologies, such as a particular type of e-money stored-value card, for example? Many of the research questions here are best tackled with market research approaches or with an experimental approach.

The adaptation of credit card payments and the use of them rather than checks in online payment systems illustrates an important research issue. This is the extent to which credit and debit cards will take over from checks and eventually become the primary payments system, at least for personal payments. One could imagine, for example, if credit cards paid interest on positive balances they would become an attractive substitute for checking and savings accounts. This will be particularly true if the time for undertaking transactions using credit cards is further reduced. Other interesting policy issues flow from this possibility for substitution of credit card accounts for checking accounts, in particular, would positive balances on a credit card account be considered a bank deposit?

4. The Impact on Financial Markets

In this section we consider the impact of electronic communication and computation on stock markets, bond markets and foreign exchange markets. In recent years a very large literature has developed on market microstructure (see, e.g., O'Hara (1995) for an overview).

Most of this literature is concerned with understanding the operation of stock markets. Traditionally stock markets were at physical locations and operated with face-to-face communication. The development of the over the counter market for stocks into the Nasdaq trading system was an early example of e-finance in the context of markets. Subsequently most stock exchanges in the world including the London Stock Exchange, The Tokyo Stock Exchange and the Frankfurt Stock Exchange have moved to electronic trading. The New York Stock Exchange, which is the largest by market capitalization in the world, still uses physical trading. However, even they have introduced the Network NYSE platform that allows retail and institutional investors to engage in electronic trading.

The foreign exchange (FX) and bond markets provide an interesting contrast to stock markets. These have traditionally been dealer markets that operate over the telephone. There has not been a physical location and trading is done directly by pairs of dealers or with the help of brokers that intermediate between them. In recent years the foreign exchange market has started to rapidly move to electronic trading. In contrast the bond market has been slow to change and is still largely a telephone market. The similarities and differences between these markets raise a number of important issues. The first is why they traditionally have such a similar market microstructure. The second is why there has been such a difference in the speed with which they have moved to electronic trading.

Stock Markets

Many stock markets around the world have adopted electronic trading methods. In the U.S., the Nasdaq market was created in 1971 to allow dealers to make over-the-counter trades on an electronic system of linked screens. It has grown rapidly and has become one of the main equity markets in the U.S. Regulatory pressures in the mid-1990s led to the entry of many

Electronic Communications Networks (ECNs) in the trading of Nasdaq-traded stocks. These electronic systems allow a wider set of participants to view limit orders (orders to buy or sell specific amounts of stock at various prices), as well as allowing for the possibility of executing trades electronically. In more recent developments, exchange based markets (including the New York Stock Exchange) have implemented various automated order execution systems, either to trade small orders, supplementing their floor-based trading systems, or as the primary means of trading. There are many important questions that have been raised and addressed regarding the growing electronification of stock trading. The effects of electronic trading on the cost, speed, and overall liquidity of trading are continuing important research questions, as are the effects on the economies of scale and market structure of exchanges.

As described by Weston (this volume), the recent growth of ECNs has enhanced competition in trading for the stocks traded on ECNs and Nasdaq. ECNs allow traders to transact directly with each other at a small fee in an electronic marketplace, thereby eliminating the need to compensate the dealer via the bid-asked spread. The ECNs allow traders to view the bids and offers in their limit-order book. In some cases these electronic limit-order books are available to the public on the Internet.[14] Traders can "hit" these bids and offers if they offer attractive prices, and "crossing" trades are automatically matched, thereby short-circuiting the traditional role of the securities dealer. ECNs can also allow traders to route orders to the dealer that offers the best price for the order. Weston shows that bid-asked spreads have declined with the growth of trading on ECNs, and that the spreads narrowed the most in the stocks that are most frequently traded on the ECNs, accounting for other factors. It is an important research issue to further investigate the source of these lower spreads. It is not clear whether ECNs brought these lower spreads from greater transparency of pricing, from greater market

interconnection, or from lower resource costs or faster speed of routing orders to best-priced dealers. These issues are important ones in better understanding market microstructure in an interconnected dealer market.

Practitioners are not all of one mind on the efficacy of electronic order execution for all market environments. In particular, some argue that adoption of electronic systems for all floor-based exchanges is not as likely to lead to improvements in market efficiency as in dealer markets.[15] Domowitz (this volume) provides cross-country evidence on this issue. He finds that the adoption of automated execution technology can reduced the total costs of order execution significantly, even in comparison to traditional, floor-based exchanges. He hypothesizes that these reduced costs can result from lower development and operating costs, as well as important liquidity advantages that arise from the greater transparency of the trading system, when compared with a specialist or non-automated system. These hypotheses frame research agenda that should be investigated. In other work, notably Domowitz and Steil (1999), Domowitz has investigated the effects of automated execution technology on market merger activity, cross-border trading, changes in methods of exchange governance, and competition. These are topical issues, especially in Europe, where significant mergers of exchanges have occurred, and where several exchanges have many exchanges have changed governance structures in the direction of becoming for-profit stock-based corporations.[16]

Sofianos (2000) points out that much trading, as in "upstairs market" trading, avoids exchanges altogether. This trading of large blocks of stock often occurs without posting limit orders with specialists on exchange floors or in automated systems. Instead, the orders stay

[14] See McAndrews and Stefanadis (2000) for a descriptive review of ECNs.
[15] These views can be found in testimony reported in the U.S. Senate Committee on Banking, Housing, and Urban Affairs (2000).
[16] See McAndrews and Stefanadis (2001) for a review of some of these developments in Europe.

"hidden" until the trader sees an opportunity to move a large block, and only then announces the willingness to trade. Sofianos expresses the view that until automated systems can accommodate these traders, the adoption of such a system might result in even more off-exchange trading (possibly at higher cost), which a researcher might not observe when calculating the costs of trading pre-and post-adoption of an automated system. Until automated systems can replicate all the functions of a floor-based system and its institutions, such as specialists, Sofianos does not believe that automated systems are capable of replacing the full functions of a floor-based trading system. Again, these views yield important questions for researchers in market microstructure.

Madhavan (2000) argues that the internet has reversed a centuries old trend towards market consolidation. The reason is that recent trends in terms of improved access to information and reductions in trading costs have greatly increased intraday volatility. This has a number of undesirable effects including increasing institutional trading costs. The internet not only allows easy access to information but also acts as a coordination device. This creates a challenge to regulators since the possibilities for manipulation are significantly increased. However, in the longer run the network externalities associated with the internet are likely deepen markets and improve price efficiency. The public policy issues Madhavan's analysis raises are an important topic for research.

Foreign Exchange Markets

Given the enormous volumes of foreign exchange that are traded on a daily basis ($1.5 trillion a day according to Banks (2001)) relatively little academic work has been concerned with foreign exchange markets. Lyons (2001) contains an excellent account of the work that has been done. He and others have developed a market microstructure approach to the foreign exchange

markets.

The foreign exchange market has traditionally been a multiple dealer market. Lyons (2001) points out that it is characterized by a number of factors. It has an enormous trading volume and trades between dealers account for most of this volume. Another important factor is that trade transparency is low. A large proportion of the trading, roughly two thirds, is interdealer trading. For many years it was a telephone-based market. Two major systems (Reuters and EBS) were developed for providing quotes. Initially, trades were still done over the telephone. However, these systems have developed into full trading platforms. Dealers are able to observe the best bid and offer in the market. Allen, Hawkins and Sato (2001) point out that the market has rapidly performed the transition from a telephone market to an electronic market. The BIS performs a triennial survey of trading between dealers. In 1995 their survey showed that 20-30% was conducted electronically, by 1998 this had risen to 50% and by 2001 it was expected to be over 90%.

Although the interdealer market for FX has largely become electronic the market between large corporations and dealers has been less affected and communication over the telephones remains important. Several internet platforms such as FXall and Atriax aim to capture this market by offering executable quotes.

This outline of the operation of the FX market raises a number of interesting questions. The first is why the foreign exchange market operated as a decentralized telephone market. The second is why the interdealer market moved so quickly to an electronic market and why the same has not yet happened to the corporate market.

Bond Markets

Similarly to the FX market, compared to stock markets relatively little academic work

has been done on the operation of bond markets. The structure of bond markets has traditionally been very similar to that of foreign exchange markets. The secondary trading in government, municipal and corporate bond markets is done over the telephone in multiple dealer markets.

To illustrate the operation of bond markets we will focus on the markets for government securities. These are large in terms of volume. Fabozzi (2001) reports that the volume of US Treasury securities that is traded daily was around $200 billion per day in the first half of 1999. The primary market involves auctions that are open to all but where a special role is played primary government securities dealers. They are expected to participate meaningfully in the Treasury auctions and interact directly with the Federal Reserve Bank of New York in open market operations. They also supply market information to the Fed. The principal market makers in the secondary market are the primary dealers. Interdealer brokers provide dealers with electronic screens that post bid and offer prices. Trades are typically executed over the telephone.

In contrast to the FX market the move towards electronic trading has been relatively slow. In the US Treasury market Allen, Harris and Sato (2001) report that 40% of securities were traded electronically in 2000. In contrast for corporate bonds only 10% were traded electronically. This is not because of a lack of bond trading platforms. Banks (2001) points out that in 1997 there were 11 online platforms. By 1999 this had increased to 40 and by 2000 to more than 80.

This sketch of the bond markets and the comparison to experience in FX markets suggests a number of important research issues. Why are bonds, particularly government bonds traded in dealer markets and not on exchanges? Are the factors that lead to this structure the same as for FX or different? Why has electronification been so slow compared to FX and other financial markets? Will the delay in electronification be temporary or more long lasting?

5. Concluding Remarks

E-finance is not new. For example, the Fedwire used electronic communications system as early as 1918. The Nasdaq market involved the electronic trading of stocks as early as 1971. The difference today is that electronic communication and computation is now used much more widely than before. A large number of people have access to the internet and this has vastly changed the opportunities for the use of electronic payments systems, the operations of financial services firms and financial markets. We have argued that this change raises a number of important research issues. For example, is the widespread use of paper-based checks efficient? Will the financial services industry be fundamentally changed by the advent of the internet? Why have there been such large differences in changes to market microstructure across different financial markets? We look forward to these and other questions being answered as the emerging field of E-finance develops.

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